BA22-DE
32-bit Deeply Embedded Processor

Implements a basic 32-bit processor for deeply embedded applications that use on-chip instruction and data memories, and is an excellent step up from the 8051 and other 8- and 16-bit microcontrollers. Part of the royalty-free BA22 family, this processor megafunction is extremely competitive in terms of high performance and low power consumption, and has best-in-class code density.

The megaffunction has an AMBA® AHB™ or Wishbone system bus interface and dedicated buses for the on-chip instruction and data memories. It includes 16 general purpose registers (GPRs), a tick-timer (TTimer), a programmable interrupt controller (PIC), an advanced power management unit (PMU), and an optional debug unit (DBGU). Additional microcontroller peripherals may be ordered for pre-integration and delivery with the megaffunction, individually or in a complete platform. IP Integration Services are also available to help integrate any BA22 processor configuration with memory controllers, image compression, or other CAST IP megaffunctions.

The processor's BA2 instruction set is relatively simple and extremely compact. Programming is facilitated with the included C/C++ tool chain, Eclipse IDE, architectural simulator, and ported C libraries.

The BA22-DE megaffunction synthesizes to 15k gates, can be clocked at nearly 400MHz in a 65nm technology, and performs up to 2.53 DMIPS/MHz.

The BA22 family of processors has been designed for easy reuse and integration, has been rigorously verified, and is production proven. Contact CAST Sales for details.

Applications
- Mixed signal embedded processing
- Internet, networking and telecom
- Home entertainment consumer electronics
- Portable and wireless
- Automotive

Features
- High Performance 32-bit CPU
  - 2.53 DMIPS/MHz
  - 2.93 MegafunctionMarks/MHz
  - Variable length (16/24/32/48 bits) instruction encoding
  - Single-cycle execution on most instructions
  - Fast and precise internal interrupt response
  - Custom user instructions
- Industry-leading code density
  - Up to 20% smaller code than thumb2
  - Lower instruction memory area & power
- Efficient Power Management
  - Further reduces power consumption by 2x to 100x using dynamic clock gating for individual units
  - Software controlled clock frequency in slow and idle modes
  - Interrupt wake-up in doze and sleep modes
- Advanced Debug Capability
  - Conventional target-debug agent with a debug exception handler
  - Non-intrusive debug/trace for both CPU and system
  - Complex chained watchpoint and breakpoint conditions
  - Industry standard Amontec JTAGKey USB to JTAG interface
- Integrated Peripherals
  - Standard: 32 bit tick timer, programmable interrupt controller
  - Options include:
    - AMBA bus infrastructure
    - Microcontroller peripherals such as GPIO, UART, Real-Time Clock, and Timers
    - Serial communication megafunctions such as I2C and SPI
    - Memory controllers, interconnect IP and more
- Easy Software Development
  - Eclipse IDE for Windows, Linux
  - ANSI C/C++ compiler, debugger, linker, assembler, & utilities
  - Architectural simulator
  - Ported libraries & RTOS
Processor Description

The BA22 family uses a 32-bit processor architecture designed for high performance with great silicon and power efficiency.

The highly configurable design may include caches and memory management units, enhanced arithmetic processing capabilities such as a divider and floating point unit, a sophisticated power management unit, and an interactive, JTAG-based debug capability.

The BA22-DE is one pre-configured version of the BA22, targeted for relatively simple deeply embedded applications.

BA22 processors are also designed for quick, efficient software development. The BA2 instruction set they use provides the highest code density in its class, without compromises on performance, ease of use, or scalability. It features:

• A linear, 32-bit or 64-bit logical address space
• An instruction length of 16, 24, 36, 48, or 64 bits, which reduces memory requirements by as much as 40%.
• Simple memory addressing modes
• Configurable general purpose registers (12 to 32 GPRs)
• Efficient memory transfer instructions

The BA22 has already proven itself in multiple production designs.

Implementation Results

The following results reported from Altera tools, assume a 4kx64 RAM connected to the IQEM bus, an 8kx32 RAM connected to the DQEM bus, that all clocks driven by a common source, and that all megafuntion I/Os are routed off-chip.

<table>
<thead>
<tr>
<th>Family Device</th>
<th>Logic Area</th>
<th>Memory*</th>
<th>Clock (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclone IV-E</td>
<td>5,845 LEs</td>
<td>66 M9K</td>
<td>63</td>
</tr>
<tr>
<td>Cyclone V</td>
<td>3,299 ALUTs</td>
<td>66 M10K</td>
<td>76</td>
</tr>
<tr>
<td>Stratix IV</td>
<td>3,338 ALUTs</td>
<td>66 M9K</td>
<td>115</td>
</tr>
<tr>
<td>Stratix V</td>
<td>3,459 ALUTs</td>
<td>34 M20K</td>
<td>153</td>
</tr>
</tbody>
</table>

* Memory required for the implementation of QMEMs, not he CPU

The provided figures do not represent the higher speed or smaller area for the megafunction. Area, power and speed depend on megafuncton configuration and tool optimizations. Furthermore power consumption depends on power management, software and memories configuration. For accurate characterization on your application please contact CAST.

Support and Services

The megafuntion as delivered is warranted against defects for 90 days from purchase. Thirty days of phone and email technical support are included, starting with the first interaction. Additional maintenance and support options are available.

IP Integration Services are also available to help minimize time to market for BA22-Based systems.

Deliverables

The megafunction is available in synthesizable HDL or targeted netlist, and includes everything required for successful implementation:

• Verilog RTL source code or targeted netlist
• Verilog Testbench
• Silicon-proven Reference SoC/ASIC Design
• Software development tools for Cygwin on Windows and Linux, with Eclipse IDE interface
• Operating systems and board support package

A reference design board running Linux and FPGA versions of the megafunction are also available; contact CAST Sales for information.

Related Products

The BA2x™ Processor Family includes a set of royalty-free, pre-configured products intended for different applications:

• BA25 32-bit Application Processor, for demanding systems running applications on general-purpose operating systems such as Linux and Android.
• BA22-AP 32-bit Basic Application Processor, for embedded applications that may need to run a full OS.
• BA22-CE 32-bit Cache-Enabled Embedded Processor, for deeply embedded systems using off-chip instruction and data memories and possibly running an RTOS; 5-stage pipeline, caches but no MMU.
• BA21 32-bit Low-Power Deeply Embedded Processor, implements a 32-bit low-power processor that delivers better performance than most processors of its size.

Platforms

• BA2x-AXI-PP Pre-integrated peripherals platform for the AMBA3 AXI bus.
• BA2x-AHB-PP Pre-integrated peripherals platform for the AMBA2 AHB/APB buses.